What is claimed is:

1. An organically-functionalized carbon nanocapsule, comprising:

a carbon nanocapsule; and

at least one kind of organic functional groups bonded thereon,

wherein the organically-functionalized carbon nanocapsule is of the following formula:

F(-E)n, in which F is the carbon nanocapsule, E is the organic functional group, and n is the number of the organic functional group.

2. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein the carbon nanocapsule is a polyhedral carbon cluster constituting multiple graphite layers having a balls-within-a ball structure, and the diameter of a carbon nanocapsule is 3-100 nm.

3. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein the carbon nanocapsule is hollow.

4. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein the carbon nanocapsule is a metal-filled carbon nanocapsule filled with metals, metal oxides, metal carbides, or alloys.

5. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein n is 1-100,000.

6. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein each E is independently E_1, E_2, E_3, E_4 or E_5, in which each E_1, independently, is Y_1,Y_2 -amino, (Y_1,Y_2 -alkyl)amino, Y_1,Y_2 -ethylenediamino, (dihydroxymethyl)alkylamino, (X_1,X_3 -aryl)amino, or X_1,X_3 -aryloxy; each E_2, independently, is Y_1,Y_2 -alkoxy, (Y_1,Y_2 -amino)alkoxy, (Y_1,Y_2,Y_3 -aryl)oxy, (dihydroxyalkyl)aryloxy, (Y_1,Y_2,Y_3 -alkyl)amino, (Y_1,Y_2,Y_3 -aryl)amino, or dihydroxyalkylamino; each E_3, independently, is Y_1,Y_2,Y_3 -alkoxy, (trihydroxyalkyl)alkoxy, (trihydroxyalkyl)alkylamino, (dicarboxyalkyl)amino, (Y_1,Y_2,Y_3 -alkyl)thio, (X_1,X_2 -aryl)thio, (Y_1,Y_2 -alkyl)thio, (dihydroxyalkyl)thio, Y_1,Y_2 -dioxoalkyl; each E_4, independently, is ((glycosidyl)oxoheteroaryl)amino, ((glycosidyl)oxoaryl)amino, (X_1,X_2,X_3 -heteroaryl)amino, (X_1 -diarylketone)amino, (X,X_1 -oxoaryl)amino, (X,X_1 -dioxoaryl) amino, (Y_1 -alkyl, Y_2 -alkyldioxoheteroaryl)amino, (Y_1 -alkyl, Y_2 -alkyldioxoaryl)amino, (di(Y_1,Y_2 -methyl)dioxoheteroaryl)amino, (di(Y_1,Y_2 -methyl)dioxoaryl)amino, ((glycosidyl)heteroaryl)amino, ((glycosidyl)aryl)amino, ((carboxylacetylalkyl)oxoheteroaryl)amino, ((carboxylacetylalkyl)oxoaryl)amino, ((isopropylaminohydroxyalkoxy)aryl)amino, or (X_1,X_2,X_3 -

alkylaryl)amino; each E_5, independently, is (X_1,X_2,X_3 -heteroaryl)oxy, (isopropylaminohydroxyalkyl)aryloxy, (X_1,X_2,X_3 -oxoheteroaryl)oxy, (X_1,X_2,X_3 -oxoaryl)oxy, (X_1,Y_1 -oxoheteroaryl)oxy, (X_1 -diarylketone)oxy, (X,X_1 -oxoaryl)oxy, (X_1,X_2 -dioxoaryl)oxy, (Y_1,Y_2,diaminodihydroxy)alkyl, (X_1,X_2 -heteroaryl)thio, ((tricarboxylalkyl)ethylenediamino)alkoxy, (X_1,X_2 -oxoaryl)thio, (X_1,X_2 -dioxoaryl)thio, (glycosidylheteroaryl)thio, (glycosidylaryl)thio, Y_1 -alkyl(thiocarbonyl)thio, Y_1,Y_2 -alkyl(thiocarbonyl)thio, Y_1,Y_2,Y_3 -alkyl(thiocarbonyl)thio, (Y_1,Y_2 -aminothiocarbonyl)thio, (pyranosyl)thio, cysteinyl, tyrosinyl, (phenylalainyl)amino, (dicarboxyalkyl)thio, $(\text{aminoaryl})_{1\text{-}20}$ amino, or (pyranosyl)amino;

each X, independently, is halide; each of X_1 and X_2, independently, is --H, --Y_1, --O--Y_1, --S--Y_1, --NH--Y_1, --CO--O--Y_1, --O--CO--Y_1, --CO--NH--Y_1, --CO--NY_1Y_2, --NH--CO--Y_1, --SO_2--Y_1, --CHY_1Y_2, or --NY_1Y_2 ; each X_3, independently, is --Y_1, --O--Y_1, --S--Y_1, --NH--Y_1, --CO--O--Y_1, --O--CO--Y_1, --CO--NH--Y_1, --CO--NY_1Y_2, --NH--CO--Y_1, --SO_2--Y_1, --CHY_1Y_2 or --NY_1Y_2;

each of Y_1, Y_2 and Y_3, independently, is --B--Z;

each B, independently, is --R_a--O--$[Si(CH_3)_2$--O--$]_{1\text{-}100}$, $C_{1\text{-}2000}$ alkyl, $C_{6\text{-}40}$ aryl, $C_{7\text{-}60}$ alkylaryl, $C_{7\text{-}60}$ arylalkyl, $(C_{1\text{-}30}$ alkyl ether$)_{1\text{-}100}$, $(C_{6\text{-}40}$ aryl ether$)_{1\text{-}100}$, $(C_{7\text{-}60}$ alkylaryl ether$)_{1\text{-}100}$, $(C_{7\text{-}60}$ arylalkyl ether$)_{1\text{-}100}$, $(C_{1\text{-}30}$ alkyl thioether$)_{1\text{-}100}$$(C_{6\text{-}40}$ aryl thioether$)_{1\text{-}100}$, $(C_{7\text{-}60}$ alkylaryl thioether$)_{1\text{-}100}$, $(C_{7\text{-}60}$ arylalkyl thioether$)_{1\text{-}100}$,

$(C_{2-50}$ alkyl ester$)_{1-100}$, $(C_{7-60}$ aryl ester$)_{1-100}$, $(C_{8-70}$ alkylaryl ester$)_{1-100}$, $(C_{8-70}$ arylalkyl ester$)_{1-100}$, --R--CO--O--$(C_{1-30}$ alkyl ether$)_{1-100}$, --R--CO--O--$(C_{6-40}$ aryl ether$)_{1-100}$, --R--CO--O--$(C_{7-60}$ alkylaryl ether$)_{1-100}$, --R--CO--O--$(C_{7-60}$ arylalkyl ether$)_{1-100}$, $(C_{4-50}$ alkyl urethane$)_{1-100}$ $(C_{14-60}$ aryl urethane$)_{1-100}$, $(C_{10-80}$ alkylaryl urethane$)_{1-100}$ $(C_{10-80}$ arylalkyl urethane$)_{1-100}$, $(C_{5-50}$ alkyl urea$)_{1-100}$, $(C_{14-60}$ aryl urea$)_{1-100}$ $(C_{10-80}$ alkylaryl urea$)_{1-100}$, $(C_{10-80}$ arylalkyl urea$)_{1-100}$, $(C_{2-50}$ alkyl amide$)_{1-100}$, $(C_{7-60}$ aryl amide$)_{1-100}$, $(C_{8-70}$ alkylaryl amide$)_{1-100}$ $(C_{8-70}$ arylalkyl amide$)_{1-100}$, $(C_{3-30}$ alkyl anhydride$)_{1-100}$, $(C_{8-50}$ aryl anhydride$)_{1-100}$, $(C_{9-60}$ alkylaryl anhydride$)_{1-100}$, $(C_{9-60}$ arylalkyl anhydride$)_{1-100}$, $(C_{2-30}$ alkyl carbonate$)_{1-100}$, $(C_{7-50}$ aryl carbonate$)_{1-100}$, $(C_{8-60}$ alkylaryl carbonate$)_{1-100}$, $(C_{8-60}$ arylalkyl carbonate$)_{1-100}$, --R_1--O--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--$(C_{1-30}$ alkyl ether, C_{6-40} aryl ether, C_{7-60} alkylaryl ether, or C_{7-60} arylalkyl ether$)_{1-100}$, --R_1--O--CO--NH--(R_2 or Ar--R_2 --Ar)--NH--CO--O(C_{2-50} alkyl ester, C_{7-60} aryl ester, C_{8-70} alkylaryl ester, or C_{8-70} arylalkyl ester$)_{1-100}$, --R_1--C--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--$(C_{1-30}$ alkyl ether, C_{6-40} aryl ether, C_{7-60} alkylaryl ether, or C_{7-60} arylalkyl ether$)_{1-100}$, --CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--, --R_1--O--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--$(C_{2-50}$ alkyl ester, C_{7-60} aryl ester, C_{8-70} alkylaryl ester, or C_{8-70} arylalkyl ester$)_{1-100}$, --R_3--O--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--, --R_1 --NH--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--$(C_{1-30}$ alkyl ether, C_{6-40} aryl ether, C_{7-60} alkylaryl ether, or C_{7-60} arylalkyl ether$)_{1-100}$, --R_1--NH--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--$(C_{2-50}$ alkyl ester, C_{7-60} aryl ester, C_{8-70} alkylaryl ester, or C_{8-70} arylalkyl ester$)_{1-100}$,

--R_1--NH--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--(C_{1-30} alkyl ether, C_{6-40} aryl ether, C_{7-60} alkylaryl ether, or C_{7-60} arylalkyl ether)$_{1-100}$, --CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--, --R_1--NH--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--(C_{2-50} alkyl ester, C_{7-60} aryl ester, C_{8-70} alkylaryl ester, or C_{8-70} arylalkyl ester)$_{1-100}$, --R_3--O--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--O--, --R_1--O--CO--NH--(R_2 or Ar--R_2--Ar)--NH--CO--NH--(C_{2-50} alkyl amide, C_{7-60} aryl amide, C_{8-70} alkylaryl amide, or C_{8-70} arylalkyl amide)$_{1-100}$, or --R_1--NH--CO--NH--(R_2 or Ar--R_2--Ar)NH--CO--NH--(C_{2-50} alkyl amide, C_{7-60} aryl amide, C_{8-70} alkylaryl amide, or C_{8-70} arylalkyl amide)$_{1-100}$;

each Z, independently, is --C--D--, wherein each C, independently, is --R--, --R--Ar--, --Ar--R--, or --Ar--; and each D, independently, is --OH, --SH, --NH_2, --NHOH, --SO_3H, --OSO_3H, --COOH, --$CONH_2$, --CO--NH--NH_2, --CH(NH_2)--COOH, --$P(OH)_3$, --$PO(OH)_2$, --O--$PO(OH)_2$, --O--PO(OH)--O--$PO(OH)_2$, --O--$PO(O^-)$--O--$CH_2CH_2NH_3^+$, -glycoside, --OCH_3, --O--CH_2--$(CHOH)_4$--CH_{24}--CH, --O--CH_2--$(CHOH)_2$--CHOH, --$C_6H_3(OH)_2$, --NH_3^+, --$N^+HR_bR_c$, or $N^+HR_bR_cR_d$; wherein each of R, R_1, R_2, R_3, R_a, R_b, R_c, and R_d independently, is C_{1-30} alkyl, each Ar, independently, is aryl.

7. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein the carbon nanocapsule is functionalized by a redox reaction.

8. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein the carbon

nanocapsule is functionalized by a cycloaddition reaction.

9. The organically-functionalized carbon nanocapsule as claimed in claim 1, wherein the carbon nanocapsule is functionalized by a radical addition reaction.

10. An organically-functionalized carbon nanocapsule, comprising:

a carbon nanocapsule; and

at least one kind of organic functional groups bonded thereon,

wherein the organically-functionalized carbon nanocapsule is of the formula:

F(-E)n, in which F is the carbon nanocapsule, E is the organic functional group selected from -OH, -C=O, -CHO or -COOH, n is the number of the organic functional group, and the carbon nanocapsule F is functionalized by a redox reaction.

11. The organically-functionalized carbon nanocapsule as claimed in claim 10, wherein the carbon nanocapsule is a polyhedral carbon cluster constituting multiple graphite layers having a balls-within-a ball structure, and the diameter of a carbon nanocapsule is 3-100 nm.

12. The organically-functionalized carbon nanocapsule as claimed in claim 10, wherein the carbon nanocapsule is hollow.

13. The organically-functionalized carbon nanocapsule as claimed in claim 10, wherein the carbon nanocapsule is a metal-filled carbon nanocapsule filled with metals, metal oxides, metal carbides, or alloys.

14. The organically-functionalized carbon nanocapsule as claimed in claim 10, wherein n is 1-100,000.

15. An organically-functionalized carbon nanocapsule, comprising:

a carbon nanocapsule; and

at least one kind of organic functional groups bonded thereon,

wherein the organically-functionalized carbon nanocapsule is of the following formula:

F(-E)n, in which F is the carbon nanocapsule, E is the organic functional group selected from -NHAr, $-N^{+}(CH_3)_2Ar$, $=CCl_2$ or amino group, n is the number of the organic functional group, and the carbon nanocapsule F is functionalized by a cycloaddition reaction.

16. The organically-functionalized carbon nanocapsule as claimed in claim 15, wherein the carbon nanocapsule is a polyhedral carbon cluster constituting multiple graphite layers having a balls-within-a ball structure, and the diameter of a carbon nanocapsule is 3-100 nm.

17. The organically-functionalized carbon nanocapsule as claimed in claim 15, wherein the carbon nanocapsule is hollow.

18. The organically-functionalized carbon nanocapsule as claimed in claim 15, wherein the carbon nanocapsule is a metal-filled carbon nanocapsule filled with metals, metal oxides, metal carbides, or alloys.

19. The organically-functionalized carbon nanocapsule as claimed in claim 15, wherein n is 1-100,000.

20. An organically-functionalized carbon nanocapsule, comprising:

a carbon nanocapsule; and

at least one kind of organic functional groups bonded thereon,

wherein the organically-functionalized carbon nanocapsule is of the following formula:

F(-E)n, in which F is the carbon nanocapsule, E is the organic functional group selected from -OH, $-OSO_3^-$, $-C(CH_3)_2COOCH_3$ or $-C(CH_3)_2CN$, n is the number of the organic functional group, and the carbon nanocapsule F is functionalized by a radical addition reaction.

21. The organically-functionalized carbon nanocapsule as claimed in claim 20, wherein the carbon nanocapsule is a polyhedral carbon cluster constituting

multiple graphite layers having a balls-within-a ball structure, and the diameter of a carbon nanocapsule is 3-100 nm.

22. The organically-functionalized carbon nanocapsule as claimed in claim 20, wherein the carbon nanocapsule is hollow.

23. The organically-functionalized carbon nanocapsule as claimed in claim 20, wherein the carbon nanocapsule is a metal-filled carbon nanocapsule filled with metals, metal oxides, metal carbides, or alloys.

24. The organically-functionalized carbon nanocapsule as claimed in claim 20, wherein n is 1-100,000.